The NIST Workshop on Reliability Issues in Nanomaterials: August 17-19, 2004

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Goals:

(a) identification of specific measurement-related barriers to successful incorporation of reliable nanomaterials into widespread engineering practice in the next 5 to 10 years;

(b) identification of measurement methodologies, standards, data, and models that might be appropriate for overcoming these barriers.

Reliability of Nanomaterials:

(i) the extent to which nanomaterials exhibit consistent mechanical behavior and associated properties over a long period of time, such as during a device lifetime;

(ii) the extent to which nanomaterial behavior and properties can be predicted over a given period.

Participation:

34 participants representing cutting-edge nanomechanics research in industry, academia, non-NIST national laboratories.

Disclaimer:
Appearance of commercial product names or companies is intended to represent actual discussion during the workshop and does not imply endorsement by NIST.

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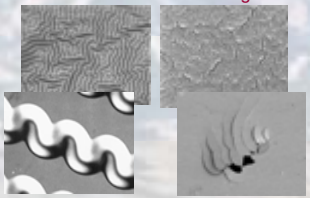
Example Issues Affecting Reliability of Nanomaterials:

- *Unusual structures/behaviors/properties*

Thin film de-adhesion under high stress



Images courtesy of Sandia National Laboratories

Si nanospheres: high strength

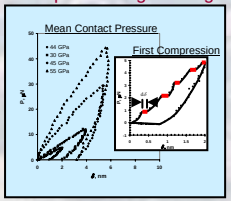


Figure courtesy of University of Minnesota

- *Operation under extreme conditions*

Cu interconnects: high current, temperature

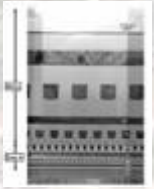


Image courtesy of IBM Corporation

NEMS/MEMS: biological environments

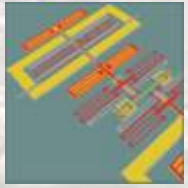


Figure courtesy of University of Colorado

- *Size/shape/distribution control*

InAs quantum dots

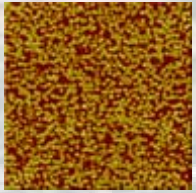


Image courtesy of NIST

Carbon nanotubes

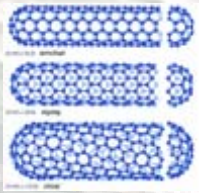
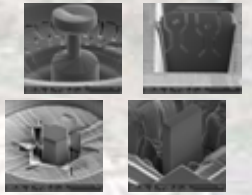


Figure courtesy of Zyvex Corporation

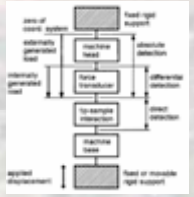
Measurement Needs:

- AFM, STM, nanoindentation:
  - Improved force, displacement measurement, position control, and general instrument consistency;
  - Direct imaging of contact areas, deconvolution of sample/probe interactions;
- Standards:
  - Reflectivity, film thickness, texture, axial/lateral microforce, AFM spring constant, AFM tip-sample contact area, calibration specimens for AFM and nanoindentation, film strength and toughness;
- Scaling of mechanical test methods and specimens (uniaxial, multiaxial, torsional stressing, deformation mapping, gripping and manipulation);
- Tools capable of multiple, coupled measurements of properties and behaviors;
- High resolution (space, energy), fast methods for imaging, morphology, chemistry, down to the single atom level;
- Methods for local measurement of: strain, electrical properties, structure size/shape, spatially-resolved temperature, stress gradients.



Novel test specimens;

Images courtesy of Sandia National Laboratories



Mechanical properties by means of nanoprobes;

Figure courtesy of Worcester Polytechnic Institute

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